All About That Base, Part 2
Solving Logarithmic Equations

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Published by *K20 Center*

Grade Level	10th – 11th Grade	**Time Frame**	80-90 minutes
Subject	Mathematics	**Duration**	2 class periods
Course	Algebra 2		

Essential Question

How do we use properties of logarithms and exponential functions to solve logarithmic equations?

Summary

In this lesson, students will discover properties of logarithms. Students will use the properties to work through a proof of the change of base formula, to solve logarithmic equations, and to evaluate logarithmic expressions. Prerequisites for this lesson include solving exponential equations using logarithms and understanding extraneous solutions and domain restrictions. This is the second lesson in the "All About That Base" lesson duo.

Snapshot

Engage

Students recall solving exponential equations using logarithms.

Explore

Students find patterns and discover properties of logarithms.

Explain

Students complete guided notes with the class and formalize their understanding of using properties of logarithms and solving logarithmic equations.

Extend

Students apply what they have learned to solve logarithmic equations and evaluate logarithmic expressions using properties of logarithms.

Evaluate

Students use the Justified True or False strategy to reflect on their learning and identify and resolve misconceptions.

Standards

Oklahoma Academic Standards Mathematics (Algebra 2)

A2.A.1.6: Solve common and natural logarithmic equations using the properties of logarithms.

A2.F.2.4: Apply the inverse relationship between exponential and logarithmic functions to convert from one form to another.

Attachments

- [Applying Properties—All About That Base, Part 2 - Spanish.docx](#)
- [Applying Properties—All About That Base, Part 2 - Spanish.pdf](#)
- [Applying Properties—All About That Base, Part 2.docx](#)
- [Applying Properties—All About That Base, Part 2.pdf](#)
- [Finding Patterns—All About That Base, Part 2 - Spanish.docx](#)
- [Finding Patterns—All About That Base, Part 2 - Spanish.pdf](#)
- [Finding Patterns—All About That Base, Part 2.docx](#)
- [Finding Patterns—All About That Base, Part 2.pdf](#)
- [Guided Notes (Teacher Guide and Model Notes)—All About That Base, Part 2.docx](#)
- [Guided Notes (Teacher Guide and Model Notes)—All About That Base, Part 2.pdf](#)
- [Guided Notes—All About That Base, Part 2 - Spanish.docx](#)
- [Guided Notes—All About That Base, Part 2 - Spanish.pdf](#)
- [Guided Notes—All About That Base, Part 2.docx](#)
- [Guided Notes—All About That Base, Part 2.pdf](#)
- [Lesson Slides—All About That Base, Part 2.pptx](#)

Materials

- Desmos account
- Guided Notes handout (attached; one per student; printed front only)
- Guided Notes (Teacher Guide and Model Notes) (attached; for teacher use)
- Pencils
- Paper
- Student devices with internet access
- Scientific calculators (optional)

5 minutes

Engage

Teacher's Note: Desmos Activity Preparation

To use this [Desmos Classroom](#) activity, select the following link: "[All About That Base, Part 2](#)." Create an account or sign in under the "Activity Sessions" heading. After you log in, the green "Assign" dropdown button will be active. Click the arrow next to the word "Assign," then select "Single Session Code." After making some setting selections, select "Create Invitation Code" and give the session code to students. For more information about previewing and assigning a Desmos Classroom activity, go to https://k20center.ou.edu/externalapps/using-activities/.

For more detailed information about Desmos features and how-to tips, go to https://k20center.ou.edu/externalapps/desmos-home-page/.

To set up the activity's pacing for students, select "View Dashboard" (next to the session code). In the upper-left corner of your screen, select the icon above the word "Pacing." Desmos Classroom should then prompt you to select the first and last screens that you want students to see. When prompted to set a range, select screens 1 and 3. Select "Restrict to Screens 1–3" to confirm your selection. This allows students to access only screens 1–3 at this time. For more information about teacher pacing, go to https://k20center.ou.edu/externalapps/pacing-activities/.

Provide students with your session code. Then, have students go to https://student.desmos.com and enter the session code.

Teacher's Note: Sign-in Options

If students sign in with their Google or Desmos accounts, then their progress is saved, and they can resume the activity or view their work later. If students continue without signing in, they can complete the activity, but they must do so in one sitting. It is strongly recommended that students sign in; otherwise, they risk losing their work.

Using the [Bell Ringer](#) strategy, have students answer the question on **screen 1**. Here, students solve an exponential equation using logarithms.

Students receive immediate feedback based on their entered responses. Use this time to address any misconceptions that still exist from the previous lesson: "[All About That Base, Part 1](#)."

Introduce the lesson using **screens 2–3** of the Desmos activity. **Screen 2** displays the lesson's essential question. **Screen 3** identifies the lesson's learning objectives. Review each of these with students to the extent you feel necessary.

20 minutes

Explore

Ask students to find partners or assign student pairs. On the Desmos dashboard, click the orange plus sign three times to allow students to progress to **screens 4–6**. Have students work with their partners to find the unique pattern on each screen.

Teacher's Note: Guiding the Activity

If students struggle with the patterns, consider allowing time for student pairs to work before bringing everyone back together to find the patterns as a class. Ask students to share their thinking so far. Having a whole-class discussion adds more ideas to the conversation and often helps students find the pattern more quickly.

Students might struggle to find Pattern 3 in particular, as it is quite a bit more challenging than Patterns 1 and 2. Allow students to have some healthy struggle with this pattern. Then, give the following hints one at a time as needed until students are able to find the pattern:

1. Remember that your observed pattern must work for all three tables in that section of the handout.
2. What is different about this third set of tables? If it is that different, then you need a different approach. Try to take a step back and look at the pattern differently from how you approached Patterns 1 and 2.
3. What have you tried that almost worked?

Students often notice that Pattern 3 is a lot like Pattern 1 until they look at the last table: The product of the first two inputs results in the last input, except in that last table. Once students reach this point, continue with the following guiding questions:

4. Is there any operation similar to multiplication that yields very similar results? (exponents/powers)
5. Could you rewrite what is in the logarithm as a number to a power?

If needed, walk students through the patterns. Promote a healthy struggle, but do not let students get to the point of frustration and quitting.

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20 minutes

Explain

Provide the attached **Guided Notes** handout to each student. On the Desmos dashboard, click the orange plus sign to allow students to progress to **screen 7**. Direct students' attention to the screen and go over the properties and their verbal descriptions with the class.

On the dashboard, click the orange plus sign again to allow students to progress to **screen 8**. Here, students go through the proof of the change of base formula.

Optional Activity

If time allows, have students use the change of base formula to get a decimal approximation of the answer to the bell ringer from the Engage portion of this lesson.

Click the orange plus sign three times to allow students to progress to **screens 9–11**. Have students use Desmos to complete the Guided Notes handout.

Teacher's Note: Guiding the Activity

See the attached **Guided Notes (Teacher Guide and Model Notes)** document for detailed explanations of the proof and the example problems. Use this document for additional support and recommendations as you walk students through the Guided Notes.

Have students add their completed Guided Notes to their math notebooks if that is a classroom norm.

Teacher's Note: Vocabulary

When applying the exponential function as the inverse of a logarithm, students might be unsure of how to articulate what is happening. Help students strengthen their academic vocabulary by using phrases like "exponentiate both sides with base b" or "apply the exponential function with base b to both sides" or "raise both sides as the power with base b." These phrases mirror the way we describe "taking the logarithm base b of both sides" of an equation. Challenge students to use this academic language when they discuss their work.

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20 minutes

Extend

On the Desmos dashboard, click the orange plus sign four times to allow students to progress to **screens 12–15**. In pairs, have students use the [Pass the Problem](#) strategy to solve the given logarithmic equations.

Have each pair of students get out a piece of notebook paper to show their shared work. Remind students that they still have to type their final answers into the Desmos activity. Explain the procedure as follows:

- For question 1, student A writes the first step in the solving process.
- Student A then passes the paper to student B, who writes the next step.
- Students continue taking turns until the equation is completely solved.
- For question 2, student B starts instead and then passes the paper to student A, taking turns until solved.

The Desmos activity has a built-in self-check on screens 12–15, so students receive immediate feedback for their responses.

On the dashboard, click the orange "Stop" button to allow students to complete the Desmos activity at their own pace. Challenge students to work independently to complete **screens 16–18**. Remind students that this is a great opportunity to reflect on what they know and what questions they may have.

Teacher's Note: Differentiation

There is more than one way to solve each of these problems using the properties of logarithms. Challenge students who finish screens 16–18 quickly to find the answer in more than one way.

Optional Desmos Pacing

If you would like to prevent students from going back to screens 16–18 to change their responses once they're done, use the Desmos dashboard to adjust the pacing:

- Click the icon above the word "Pacing" and select screens 19 and 26.
- Select "Restrict to Screens 19–26" to confirm your selection.

This allows students to access only screens 19–26 for the rest of the lesson, similar to collecting student responses on a handout in class.

15 minutes

Evaluate

Use the [Justified True or False](#) strategy to see which common misconceptions students may still have. For **screens 19–26**, have students work with their partners to determine if each statement is true or false with justification. Students receive peer feedback on each screen—once they make a selection and submit their justification, they can see what their peers thought.

Use the dashboard to monitor student responses. Check for misunderstandings and bring the class back together to clarify misconceptions as needed.

> **Teacher's Note: Desmos Feedback**
>
> Remember that screens where students explain their thinking in words do not display a check mark on the dashboard. These screens instead show either a dot, which indicates the non-text answer is correct and you just need to check the text response, or an "x," which means the non-text answer is incorrect.
>
> For example, if a student selected false on screen 19, then the dashboard would show a dot, since that is the correct answer. If a student selected true, then the dashboard would show an "x," since true is not the correct answer.
>
> However, the dashboard does display a check mark on screen 1 for students who entered the correct answer, since there is not a place to type words on that screen.

Resources

- K20 Center. (n.d.). Bell Ringers and Exit Tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Justified True or False. Strategies. https://learn.k20center.ou.edu/strategy/174
- K20 Center. (n.d.). Pass the Problem. Strategies. https://learn.k20center.ou.edu/strategy/151
- K20 Center. (n.d.). Desmos Classroom. Tech tools. https://learn.k20center.ou.edu/tech-tool/1081